

Data Mining Activity for Bone Discipline: Calculating a Factor of Risk for Hip Fracture in Long-Duration Astronauts

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The factor-of-risk (Φ), defined as the ratio of applied load to bone strength, is a biomechanical approach to hip fracture risk assessment that may be used to identify subjects who are at increased risk for fracture. The purpose of this project was to calculate the factor of risk in long duration astronauts after return from a mission on the International Space Station (ISS), which is typically 6 months in duration. The load applied to the hip was calculated for a sideways fall from standing height based on the individual height and weight of the astronauts. The soft tissue thickness overlying the greater trochanter was measured from the DXA whole body scans and used to estimate attenuation of the impact force provided by soft tissues overlying the hip. Femoral strength was estimated from femoral areal bone mineral density (aBMD) measurements by dual-energy x-ray absorptiometry (DXA), which were performed between 5-32 days of landing. All long-duration NASA astronauts from Expedition 1 to 18 were included in this study, where repeat flyers were treated as separate subjects. Male astronauts ($n=20$) had a significantly higher factor of risk for hip fracture Φ than females ($n=5$), with preflight values of 0.83 ± 0.11 and 0.36 ± 0.07 , respectively, but there was no significant difference between preflight and postflight Φ (Figure 1). Femoral aBMD measurements were not found to be significantly different between men and women. Three men and no women exceeded the theoretical fracture threshold of $\Phi=1$ immediately postflight, indicating that they would likely suffer a hip fracture if they were to experience a sideways fall with impact to the greater trochanter. These data suggest that male astronauts may be at greater risk for hip fracture than women following spaceflight, primarily due to relatively less soft tissue thickness and subsequently greater impact force.

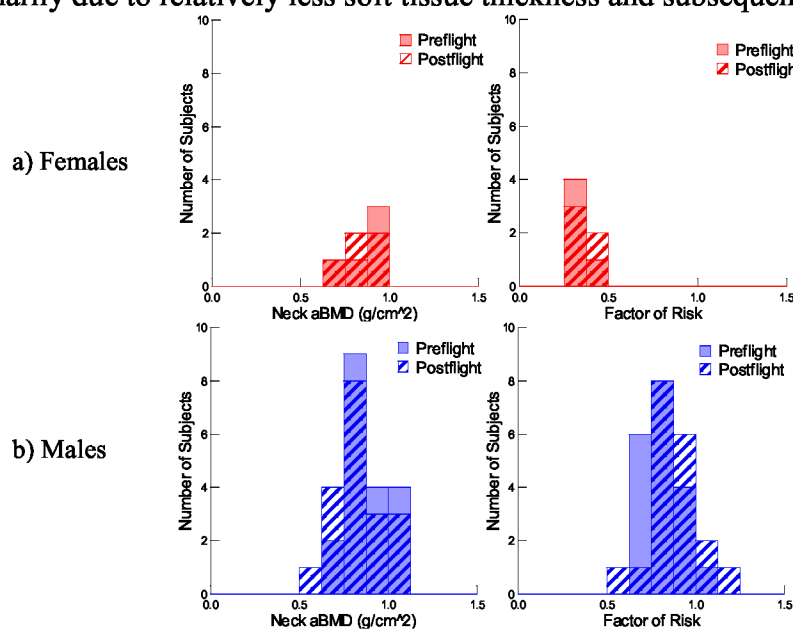


Figure 1. Pre- and postflight calculations of femoral neck aBMD and factor of risk (Φ) for hip fracture in a) females and b) males.